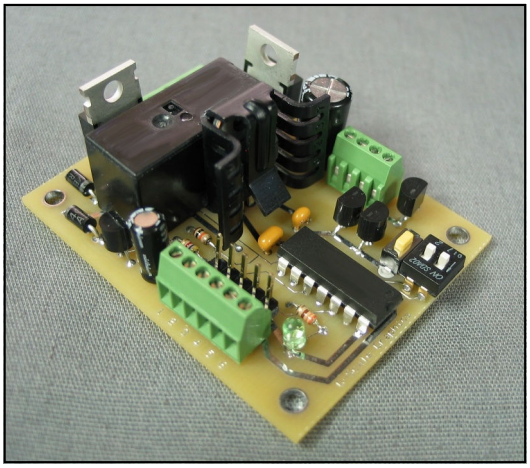
Enhanced Critter Control

Operation and Installation Manual



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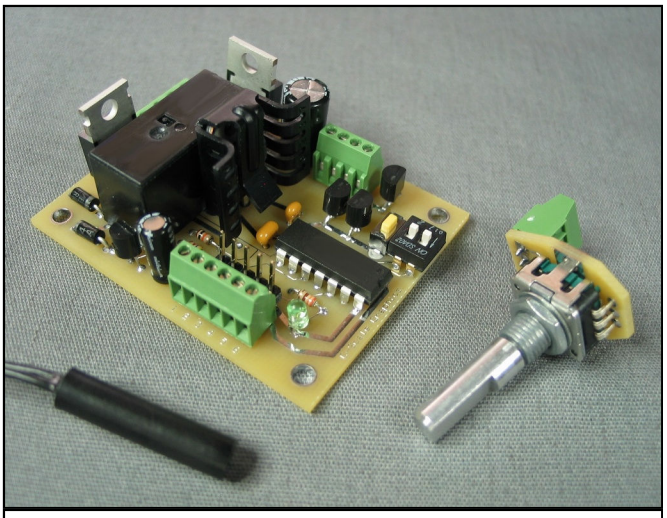
Overview

The Enhanced Critter Control is a simple way to manually or automatically control large scale battery powered “Critters” or large scale locomotives, hands-on, without the expense and frustration of radio control systems or complex track wiring. Whether you simply want to run your trains continuously on either a loop or point-to-point layout, do switching in the yards, or have a series of automated station stops, this control system will meet your needs.

The Critter Control is also a simple way to control a 2nd train on your layout. Speed is readily adjustable, so just set it close to that of your other train, then run at a fixed speed while you control the primary train using your power-pack or radio control as needed to keep them separated.

Unlike a simple on/off battery power scheme, the Critter Control smoothly accelerates and decelerates prototypically, which also avoids gear damage.



Enhanced Critter Control board, reed switch, and rotary speed switch module with built-in push button.

A powerful micro-controller handles all of the control logic and sends signals to a 5 amp motor driver. The driver is large enough to handle most locomotives pulling a full train, yet the board is small enough to fit in most “Critters”.

Manual Hands-On operation - A roof mounted rotary switch with built-in push-button is the primary control. Push the button to start the train. The train will smoothly accelerate to your previously set running speed. Push the button again and it will decelerate to a stop. The same button can be used to reverse direction or make emergency stops. Running speed is adjusted by rotating the switch as your train passes by. Since the speed setting is retained in non-volatile memory, you won’t have to do this often. And, it will still be there the next time you power up. Acceleration rates are user programmable.

Automated operation - Back ‘n forth trolley operation and continuous loop operation with multiple station stops are built into the Enhanced Critter Control system. Track mounted magnets and a loco mounted reed switch initiate deceleration to a stop at the station, where it will stay for a user programmable period of time, and then accelerate back to running speed (the rate of acceleration is also programmable). A second magnet in the path during slowdown to the station will initiate direction reversal after the timed stop. Station stops can also be programmed for random operation adding interest to your layout.

For track dedicated to back ‘n forth trolley operation, with no intermediate station stops, one magnet can be used at each end to decelerate and reverse the trolley. (See Programming options).

The Enhanced Critter Control consists of a small circuit board (2.4”L X 1.9”W X 1.0”H) and off-board speed control. This gives you the freedom to mount it where ever you want. A rotary switch with built-in push button makes for a simple one-piece control that can be easily disguised as a smoke stack or vent. The reed switch can be mounted under your loco to implement automated station stops and/or back ‘n forth trolley operation.

Note: To complete your battery power conversion, you will also need to provide a power on/off switch, battery pack, battery charger, and battery charging jack (optional). The G-Scale Graphics “Battery Conversion Modules” combine some of these functions and reduce wiring.

Directional lighting outputs are provided to power your locomotive’s front and rear lights; LEDs or lamps. No external resistors are required for LEDs.

The on-board LED and built-in diagnostics allow you to verify proper wiring connections right on the bench. It also provides a visual indication of proper reed switch operation.

Installation

Track Power to Battery Power Conversion

All track powered locomotives are very simple, electrically. Track power is picked up from the rails via pickups and usually connected directly to the motor. Sometimes there are switches in the circuit to reverse polarity or turn off the motor. These connections need to be modified in order to properly connect the battery powered driver board.

Converting to battery power consists of these basic steps.

1. **Determine battery voltage requirements.**
   Before you disturb any wiring, run your locomotive at the fastest speed you like to run on your layout and measure the track voltage. Add at least 2 volts to this measurement to account for low batteries and driver losses. Round this value up to the nearest 1.2v increment, and you have the number of cells you need.

   For example: Track voltage measures 11.6V at speed. (11.6 + 2)/ 1.2 = 11.3. You will need at least 12 cells. 12 X 1.2V = 14.4V. (14.4V is a popular value for steam locomotives. Many critters can run on 12V. Diesels usually require 18V or more).

2. **Disconnect the track power pickups.**
   By isolating your locomotive from track power, you can run more than one locomotive on the same track at the same time, either battery powered or track powered. If you don't do this, your battery will be directly connected to your track power supply, resulting in damage. Note that in doing this, you have also removed power from all lighting circuits, smoke units, and any other accessories that were running from track power. For battery power, smoke units are usually not used due to the high current requirements that will quickly drain the battery pack. Understanding existing wiring and/or circuit boards without documentation can be difficult. You may choose to just remove it all and wire directly to things you can see and understand.

3. **Find a direct connection to the motor.**
   The output of the controller needs to be connected directly to the motor. All other control boards and switches must be removed from the circuit. Depending on the design of the locomotive, this may be an extremely simple process, or it may be difficult. Some motor blocks make it very simple. You will find two pairs of wires. One set goes to the track pickups, and the other goes to the motor. You can verify which pair goes to the track pickups using a continuity checker or ohmmeter. Track pickups will have continuity from one pin to one set of wheels. The motor will read a small resistance value across the two wires (e.g. 18 ohms). Simply disconnect the track pickup pair and connect the motor pair to the controller.

4. **Install all of the components and wire them together**
   (battery pack, power on/off switch, charging jack, controller, and lights)

   Installing the new components is a packaging exercise. Where will it all fit? Space for the battery pack and control board is usually the biggest consideration. And, where to locate the switches so they are accessible?

Wiring

Always use stranded wire and tin the ends with solder prior to making any connections. Wiring for the control inputs at terminals 1 thru 10 can be smaller gauge wire (26 Ga.). Wiring for the power input and motor output circuitry on terminals 11 thru 14 needs to be heavier gauge wire (20 or 22 Ga.) Any wiring connections or splices not directly connected to a component must be covered. Use heat shrink tubing or wire nuts.

Skills

All connections to the Rotary Critter Control can be made via screw terminals. However, basic wiring and soldering skills are required to make proper connections to the toggle speed switch version, power on/off switch, and charging jack. Some drilling and minor fabrication or modifications to the unit under conversion may also be required.

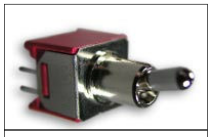
Tools & Materials

A low wattage soldering iron, side cutters, needle-nose pliers, wire strippers, a 1/16" or 5/64" slotted screwdriver, resin core solder, 26 and/or 22 Ga. Wire, and heat shrink tubing are recommended to properly complete the wiring. A suitable drill, PCB stand-offs, and double-sided foam tape may be useful for mounting components.

Installation of the Critter Control Board

The Critter Control board can be mounted most anywhere, but allow space for access to wiring. No metal should be in contact with the board. The power components (heat sink and large metal tab) will get hot, so keep them out of direct contact with plastic. Mounting holes in the corners of the board may be used along with stand-offs for a professional installation, or simply use double-sided foam tape on the bottom side of board to secure the board to a plastic surface. Handle the board by the edges, avoiding direct contact with the circuitry. Static electricity can damage the components. Try to ground yourself by touching something metal prior to handling the board. Refer to the wiring diagrams at the end of this manual.

Power Input (Battery)



Power On/Off switch

The Critter Control will not function below 7v input at terminals B+, B-. Reverse polarity will not cause damage, but the control will not operate. Voltage in excess of 30V may cause damage. Battery packs of 8 to 20 cells are suitable (nominal 9.6 to 24.0V). A 20 cell pack can charge up to 30.0V. An 8 cell pack can discharge to 8.0V.

Charging Jack

When making wiring connections to the battery pack, use extreme caution to avoid shorting the leads together. Do not connect the battery to the circuit until all other wiring has been completed. The battery pack should have a quick disconnect connector for safety and ease of replacement.

> ***Note: Make sure terminal B+ is positive (+) and terminal B- is negative (-). This product is not intended for track power applications where polarity reverses.***

The power on/off switch can be located on the floor under the loco. If you have a critter, the charging jack can also be floor mounted, since you will probably take it off the track for charging. For a full size locomotive and/or tender, you may want to locate the charging jack on the end of the car to enable charging in place on the track. The switch in the charging jack isolates the battery from all other electronics when a jack is plugged in, regardless of the position of the power on/off switch. ***Warning! The heat sink on the voltage regulator may be extremely hot; enough to burn you if touched, or melt any plastic it comes in contact with.***

> ***Warning ! A 5 amp fuse should be installed in-line with the positive battery lead to protect against accidental short circuits, which may damage the control, and melt wiring and/or plastic.***

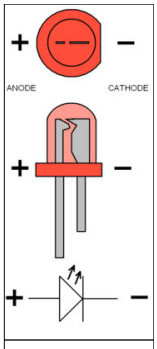
Motor Output

Connect terminals M+ and M- directly to the motor. All other unknown circuitry must be disconnected from the motor. A maximum of 5 amps continuous current is available from the board. ***Warning! At 5 amps the power transistor on the board (metal tab) will be extremely hot. Enough to burn you if touched, or melt any plastic it contacts.***

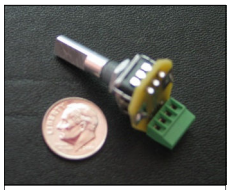
At power-up the motor output will provide a voltage to the motor that is positive on terminal M+, negative on M-. This is intended to be the forward direction of the locomotive. It will work either way. But with this polarity the board will draw considerably less current in the forward direction, thus reducing heat, and extending battery life, assuming you do most of your running in the forward direction. For automated back and forth operation, it will make no difference.

Directional LED Outputs

Connect directly to the LEDs; terminal 8 to the anodes(+), and terminals 9 and 10 to the cathodes(-) of the forward and reverse LEDs respectively. No current limiting resistors are required. To provide constant current to one or more LEDs, regardless of direction, jumper terminal 9 to 10, and connect the LED anode(+) to terminal 8, and the cathode(-) to either terminal 9 or 10.



LED



Rotary Switch (& dime)

Control Inputs

The controls should be mounted where they can be easily reached as the critter or train passes by, usually roof mounted. The rotary switch is designed to accept a radio knob using a set screw. A false smoke stack or vent can be fabricated to act as the knob. The shaft can also be shortened. Wiring connections are made via screw terminals.

A reed switch is only required for automated operation. It must be installed within 1/4" of track magnets, in either a horizontal or vertical orientation. You can usually mount it on the underside of a truck in the horizontal position parallel with the track. Silicone adhesive works well. Or, it can be vertically mounted through a 1/4" diameter hole in the floor of the vehicle. Do not mount the reed switch below the level of rail tops, as it will hit the rails in turnouts.

Reed Switch

Testing

The on-board green LED can be used to check out your wiring and most of the board functions. This should be all you need to get going, but if you are still having problems and you have a volt-ohm meter you can also take the measurements indicated below.

Power-up (LED ON)

When power is first applied to the board, the LED should be ON steady. This tells you the power input polarity is correct and the Critter Control's 5V power supply is working. Measure +5.0 +- 0.5 VDC at terminal 1+, 5-. If there is a problem, check the voltage and polarity at terminals B+, B-. It should measure between +7.0 and +30.0 VDC.

Speed Setting Switch (LED flashes OFF)

Rotate (or toggle) the switch in either direction. The LED should flash rapidly. You could also measure the voltage at terminal 2+, 5-, and terminal 3+, 5-. The voltage should momentarily drop from 5V to 0V. If not check the wiring of the speed switch.

Reed Switch (LED OFF when activated)

While in the stopped mode, anytime a magnet is passed within range of the reed switch, the LED will turn OFF until the magnet is removed or out of range. This is very handy to check your reed switch and magnet alignment. Slide the loco back and forth over the magnet, while watching the LED. Your magnet height should be just under the top of the rail. The reed switch should be just above the top of the rail. There should be less than 1/4" spacing between the magnet and the reed switch. Measure the voltage at terminal 6+, 5-. The voltage should momentarily drop from 5V to 0V. If not, check the reed switch wiring.

Push-Button (LED flashes, then OFF)

When you press the button, the LED will flash a couple of times, then turn OFF. This indicates the button worked and you are now in the run mode. The motor should accel to the set running speed. CW rotation increases speed. CCW decreases speed. Pressing again should decel the motor to a full stop and turn on the LED. If the LED won't flash when the control button is pressed, check the rotary switch/control button wiring. Measure the voltage at terminal 4+, 5-. The voltage should drop from 5V to 0V when the button is pressed. If the motor doesn't run after increasing the speed setting, check the motor wiring. Voltage at terminals M+, M- should increase with increasing speed, to a maximum of your battery voltage. If the loco runs backwards, reverse the wiring at terminals M+ and M-.

Changing Direction

At power-up, direction is set to "forward", and the forward light should be ON (if connected) and the reverse light OFF (if connected). While stopped, a quick momentary button press, followed by a longer press will start the loco in the opposite direction. You may hear the relay click. The reverse light should now be ON, and the forward light OFF when running in reverse.

Manual Operation

Power-Up
When you first power-up your Critter Control it will be in the "Fully Stopped" mode and the on-board diagnostic LED can be used to check wiring connections, as previously described.

Auto / Manual Operation
By default, the control powers up with automated station stops enabled. However, there may be times you don't want to make the station stops. You can disable auto mode without removing your track magnets. Just hold down the control button for about 1 second while turning on the power. To go back to auto mode, cycle power off, then back on (control button not used). Note: If you hold the button down for 5 seconds or more, you will enter the motor starting voltage mode.

Starting and Stopping
Press the control button to start. The locomotive will accelerate to running speed. Press it again, and it will decelerate to a stop. Press and hold the button anytime for an emergency stop. During a timed station stop initiated by a track magnet, a button press will halt the timer and the locomotive will remain stopped.

Speed Changes
Changes to running speed can only be made while actually running at speed. Controls will have no effect during stops or while accelerating or decelerating. Roof mounted controls make it easy to adjust speed as the locomotive passes by.

Rotary Switch -
There are no physical stops but you can feel detent positions as it is turned. CW rotation increases speed, CCW rotation decreases speed.

Memory -
The current speed setting is always retained in non-volatile memory. So, the next time you power-up and press the button, you will return to the same speed you were running during your last operating session. The speed setting is saved every time you initiate a stop.

Changing Direction
While fully stopped, a quick momentary button press (< 1/2 sec) followed by a longer press (about 1 sec) and release will cause the locomotive to change direction.

Set-Up

Motor Starting Voltage
When you press the control button to start your loco, the voltage starts ramping up from 0 volts. However, your motor will require something greater than 0 volts to start moving, perhaps 1 or 2 volts. The result may be a considerable delay between the time you press the button and motion of your locomotive. This can be adjusted, but try it at the factory setting of 0 volts first. Then if you need to change it, here's how ...

1. Prior to turning on the battery power, hold down the control button.
2. Turn on the battery power and continue to hold the control button for at least 5 seconds. After 5 sec, the on-board diagnostic LED and the forward light output (if you are using it) will flash 5 times. You are now in the motor starting voltage calibration mode. (Both the forward and Reverse lighting outputs will be on during this time.)
3. Increase the speed setting until the motor just starts moving, then decrease it slightly.
4. Press the control button. The on-board LED will flash 5 times, indicating your new motor starting voltage has been saved and you are now back in the stopped mode, and can resume normal manual operation.
5. Experiment with starting and stopping the loco. If there is still a significant delay, you may need to raise the starting voltage a bit. If the loco jumps when starting, instead of smoothly accelerating, you may have the starting voltage set too high.
6. If you power down and go back into the motor starting voltage mode again, the motor voltage will return to the last setting you made. You can now raise or lower it from that point.

Note: Upon exiting the motor starting voltage mode, automation will be disabled. To restore auto operation, cycle battery power off and back on.

Trouble Shooting

Manual Operation

- Nothing seems to be working …
  Check the power. The on-board LED should be ON when you first power-up.
  You should measure between 7 and 25 volts DC applied to terminals B+, B-.
  You should measure 5 volts DC on terminals 1(+), 5(-)
  Verify all wiring connections.

- Pressing the button, but it won't go …
  Press and hold the control button for a couple of seconds to insure you are in the "Fully Stopped" mode.
  Then momentarily press the control button. If it doesn't go, increase the speed setting.
  (Also try decreasing the speed setting, in case it is wired backwards.)
  If it still doesn't accelerate, remove power and try again.

- When I first power up and accelerate to speed, the loco runs in reverse ...
  Reverse the wires at the motor output, terminals M+.M-.
  It is preferable to run in the forward direction after power-up to conserve battery life.

- The loco won't run as fast as I like even though I keep trying to increase the speed setting …
  Maximum speed is determined by your battery voltage. You need more cells/voltage.

- The speed setting control is working backwards …
  Reverse the wiring at terminals 2 & 3.

- Can't change the speed ...
  The speed setting switch will only work while running at speed. Speed cannot be changed while stopped, accelerating, or decelerating.

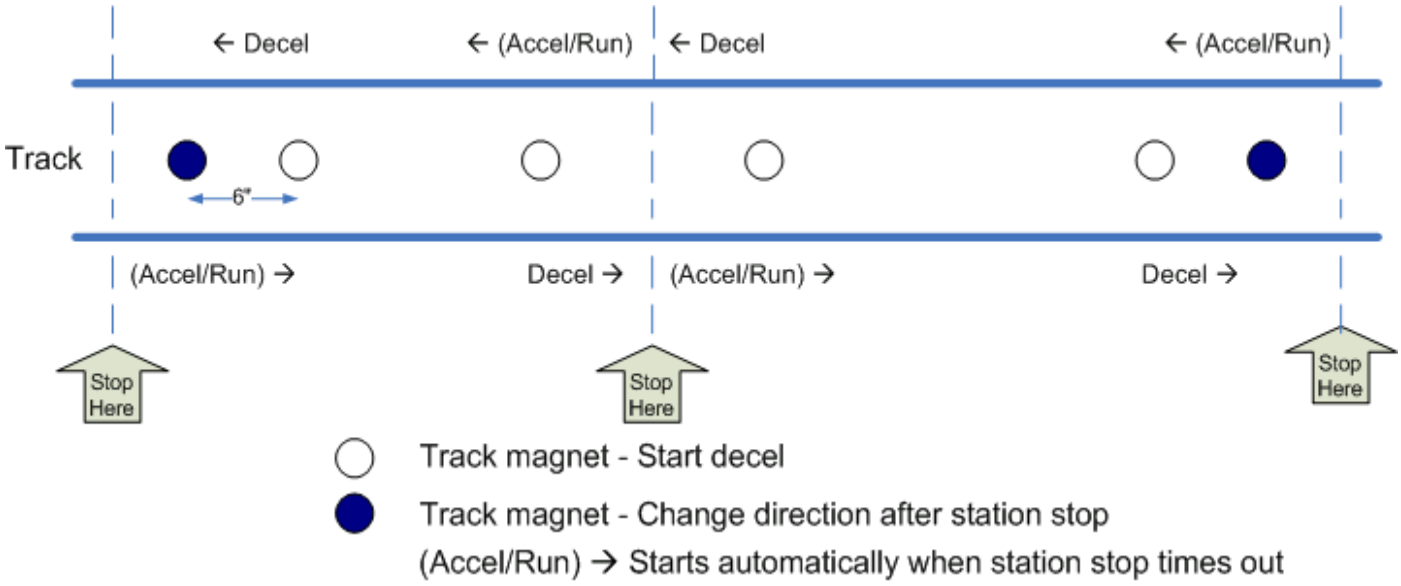
- The speed setting seems to be changing on me...
  The "Speed Setting" is actually a "% of battery voltage setting". Hence, as the battery voltage decreases during discharge, the speed will slow down some. Also, changes in load, such as adding more rolling stock to the train, will decrease speed slightly.

- Loco starts moving as soon as I turn on the power …
  The motor starting voltage is set too high

Automated Operation

An automated station stop slows down the train, waits at the station between 15 and 60 seconds, depending on the programmed value, then accelerates back to running speed. Station stops add interest to your open house or public displays.

Automated operation is easily achieved with the Enhanced Critter Control. You just need to add a reed switch to your locomotive and place some track magnets on your layout.



Automated station stops are initiated by a track magnet placed ahead of the station. The magnet initiates deceleration to a stop. You can make as many stops as you like, one magnet per station. When running in both directions, two magnets per station are required, one for each direction. Place the magnets such that the loco stops at the same location when running from either direction. The magnet in front of the locomotive when leaving the station will be ignored.

The distance the magnet is located from the station will depend on your running speed. Some trial and error will be required to find the proper location. First, establish your running speed. Since your running speed is maintained in memory, the distance will never change unless you vary the running speed.

Avoid the repetition of a station stop every time a magnet is encountered by programming random station stops. You can control the percentage of time the train will stop after crossing the magnet. This adds an incredible amount interest to your layout for both you and your visitors.

For tracks with intermediate station stops, automated reversing is accomplished using a second magnet placed about 5” to 8” after the decel magnet. This second trigger will cause the loco to depart the station in the opposite direction. Magnet spacing requirements vary with speed of the loco. 6” or greater is a good starting point. As long as the second magnet is crossed prior to coming to a full stop, it should work. *Caution: You should provide for end of track bumpers or wheels chocks, just in case.*

For track dedicated to back ‘n forth trolley operation, you can use just one magnet on each end to start deceleration and automatic reversal. (See Programmins options.)

Any magnet of suitable size and strength can be used. But they must be located no more than 1/4” from the reed switch passing overhead. Track magnets mounted higher than the rail tops will be susceptible to damage by track cleaners and snow plows.

But I already use magnets to trigger my sound system!

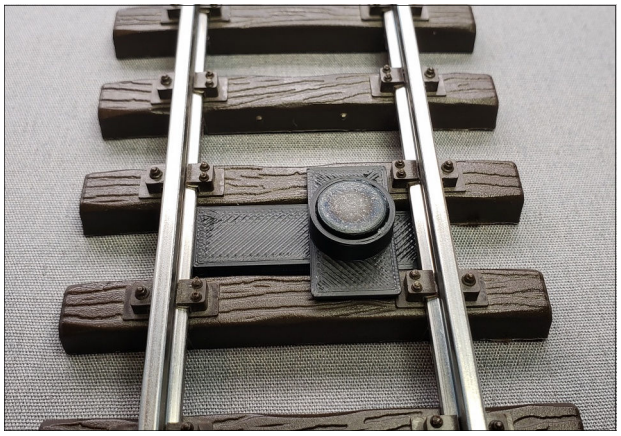
You may have existing track magnets used to trigger the bell and whistle of your sound system. For example; whistle magnet on the right, bell on the left. Both systems can share the same magnets fairly easily. Install your Critter Control reed switch on the same side you use to trigger the bell. The bell will ring as you approach the station, and the whistle will still blow in your favorite locations. If your sound board uses the negative battery terminal for common, you can also share the same reed switch. One side to common, the other side to both the sound board and the Critter Control.

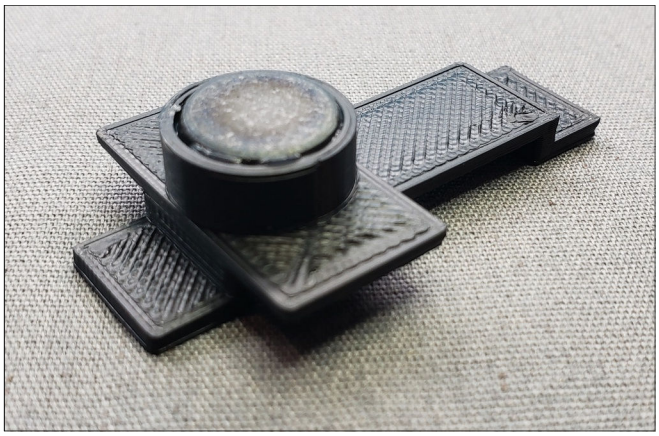
Movable Magnets

Being able to easily move your magnets to new track locations makes it much easier to set up your station stops, or change things as the need arises. If you just place a loose magnet in between ties, the metal of the loco may pick it up as it passes.

G-Scale Graphics Track Magnets are designed for two reed switches placed 1.0" apart. They are easy to insert between track ties, and easy to move. They can also be rotated for use as a "left' or "right" side magnet.

The two magnets for reversing should be placed at least 5" apart for slow moving locos, at least 8" apart for fast moving locos.





Trouble Shooting Automated Operation

- Loco fails to stop after crossing a single decel magnet. Verify proper installation of reed switch and magnet.
- If the loco fails to reverse after *crossing* two magnets, the magnets are too close together and/or the loco speed is too fast. Random station stops must be set for 100%.*(Hence the need to protect the end of point-to-point track with a bumper or derail).*
- The loco will also fail to reverse if the magnets are too far apart and/or the loco is running too slow. It will cross the first magnet, but stop prior to the second, and treat it as a station stop.
- If you can't get the loco to make a proper intermediate station stop in both directions after making the above adjustments, it may be due to excessive grade of the track. Intermediate station stops work best with a flat approach from both directions but should tolerate 3% grades.
- The location of the station stop changes over time. Magnet locations are only precise for one given speed setting. As the battery discharges, the loco will slow somewhat, even though the speed setting has not been changed. This effects the stopping distance after a magnet trigger.

Programming Procedure for Enhanced Critter Control

User configurable parameters can be programmed using the 2-position DIP switch, on-board push-button switch, and on-board LED.

Enter Programming Mode
With power on, momentarily press the yellow push-button located next to the DIP switch. The LED will begin flashing.

Select Parameter
Select the parameter you wish to view or program using the DIP switch. (the white square indicates position of the switch; e.g. for parameter 0, all switches are in the down or off position.

View Current Option Code
The LED will flash the option code for the currently selected parameter; e.g. two flashes followed by a pause indicate option 2.

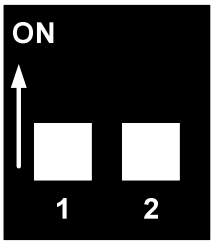
Change the Option Code
Momentarily press the push-button during the pause to advance the option to the next higher number, until you get the desired number of flashes.

Save the Option Code
Press and hold down the push-button for about 4 secs until the LED starts flashing rapidly, which indicates the save is complete.

Select the next Parameter
Repeat the above as needed to view or make changes to other parameters.

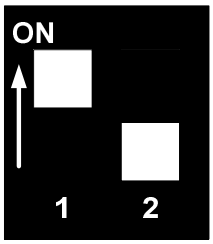
Exit Programming Mode
Turn off power.

Upon return to power, the new options will be activated.

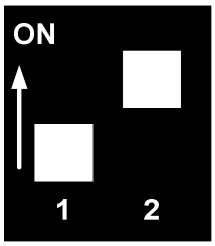


DIP Switch

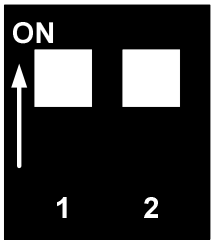
Option	Parameter 0 - Station Stop Dwell Time
1	5 secs
2	10 secs [factory setting]
3	20 secs
4	30 secs



Option	Parameter 1 - Station Stop Accel/Decel Time
1	Fastest
2	Faster
3	[factory setting]
4	Slower
5	Slowest



Option	Parameter 2 - Station Stops from Reed Switch
1	100% / Trolley mode. [factory setting] Reed Switch always triggers a station stop. TWO magnets to reverse.
2	75%, Reed Switch triggers station stop 75% of the time
3	50%, Reed Switch triggers station stop 50% of the time
4	25%, Reed Switch triggers station stop 25% of the time
5	0%, Reed Switch triggers station stops 0% of the time
6	100% Trolley mode. ONE magnet reverses. Reed Switch always triggers a station stop and then reverses.



Option	Parameter 3 - Button Press Accel/Decel Time
1	Fastest
2	Faster
3	[factory setting]
4	Slower
5	Slowest

Enhanced Critter Control Specifications

Board Revision "D"

Mechanical

Physical Size: PCB – 2.4" X 1.9", Max component height – 1.0". Weight: 1.3oz.
User Connections: Screw clamp terminal strips accept individual wires, 30 to 20 AWG.
Requires a 1/16" or 5/64" slotted screwdriver

Electrical

Power Input from battery pack (Terminals B+,B-)
7.0V min to 25.0V max
8-20 cell battery packs
Nominal 9.6V to 24.0V battery packs (1.2V per cell)
8 cells can discharge to 8.0V (1.0V per cell)
20 cells can charge to 30.0V (1.5V per cell)
Reverse polarity protection

Power Consumption (due to board, no motor load)
Forward motor direction: < 50 ma (30V supply)
Reverse motor direction: < 150 ma (Relay energized, 30V supply))

Motor Output (Terminals M+,M-)
5 amps max, continuous
PWM (Pulse Width Modulated)
Polarity reversal via relay contacts
Max amplitude: Battery voltage minus driver loss
Typical voltage loss across driver: 0.1V @14.4V, 1A: 0.3V @24.0V, 2.5A.

Control Outputs

LED/Lamp Drivers: Max load = 500 ma
LED current source: Terminal 8 = 20 ma
Lamp voltage source: Terminal 7 = battery voltage at power input
Forward Lamp/LED-(open collector) Terminal 9
Reverse Lamp/LED-(open collector) Terminal 10

Control Inputs

Control Switch Input (Terminal 4)
Momentary push-button switch (NO), contacts normally open, built into rotary speed switch

Speed Setting Inputs (Terminals 2,3)
Rotary Encoder switch; quadrature output, 24 pulses per revolution (drill 9/32" hole)
approximately 2 full turns min to max speed

Reed Switch (Terminal 6) (drill 1/4" hole)
SPST - Normally Open, installed within 1/4" of track magnet, vertical or horizontal orientation

Track Magnets
Must be placed on roadbed within 1/4" of reed switch.
Spacing for pair of reversing magnets: 6" nominal. No more than distance required to decel to a full stop.
Minimum track length for auto reverse operation: Depends on speed; about 7 feet.

Battery Power Accessories (available from G-Scale Graphics)

Battery Conversion Module; (built-in Power on/off Sw, Charging Jack, 5A fuse, power distribution)
Power On/Off Switch: Sub-Miniature w/short handle, SPDT (On-On), 3A, 28 VDC (drill 3/16" hole)
Charging Jack: 2.5mm, 5A, w/switch (drill 5/16" hole)

Enhanced Critter Control
With Rotary Speed Switch

Wiring Diagram

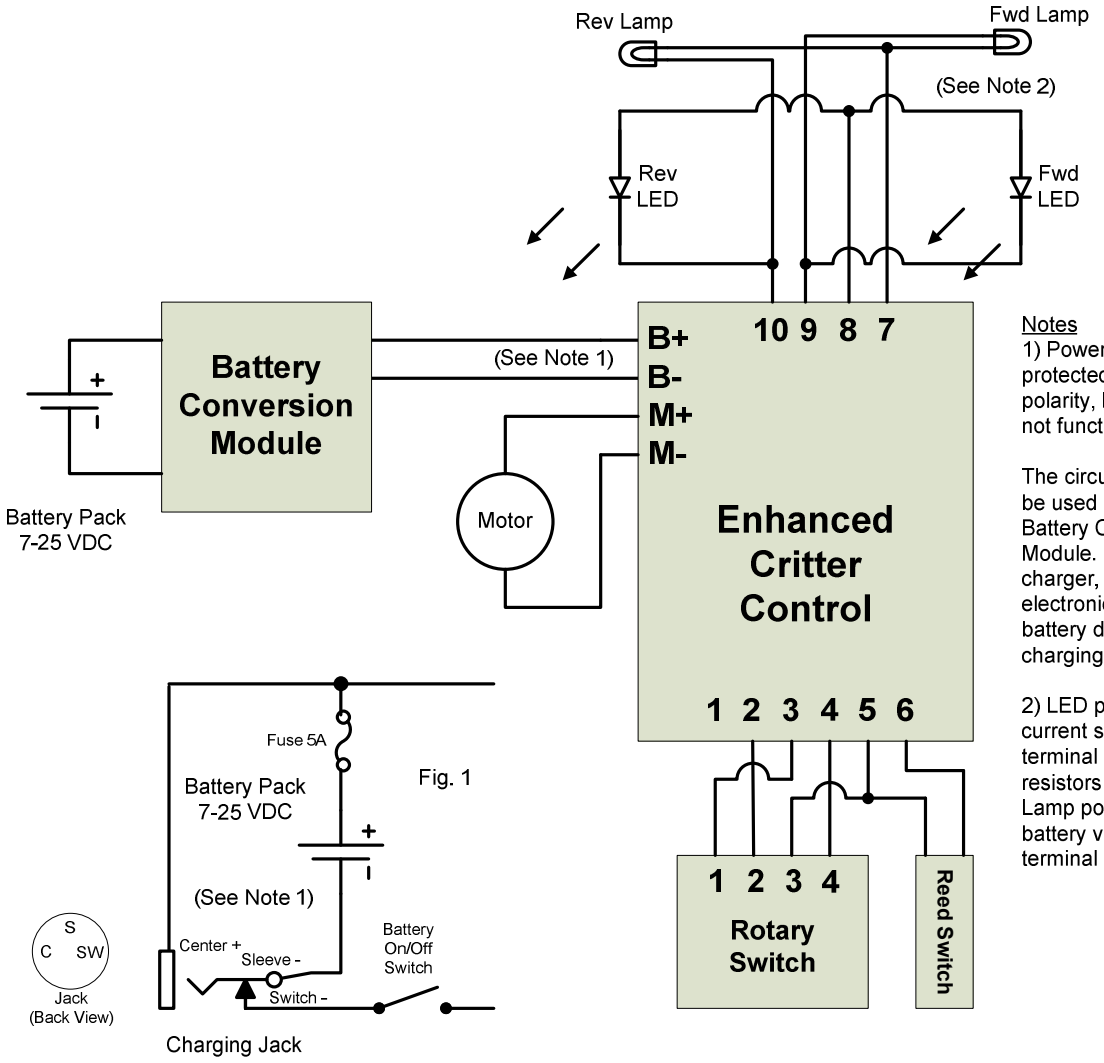


Fig. 1

Notes
1) Power input is protected from reverse polarity, but control will not function.

The circuit in Fig 1 can be used in lieu of Battery Conversion Module. Plugging in charger, isolates all electronics from the battery during charging.

2) LED power is 20 ma current source from terminal 8. No resistors are required. Lamp power source is battery voltage from terminal 7.